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# The Association of Iron Deficiency Anemia with 3-5 of Kidney Disease Stages Case-Control Study

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**Abstract:**

Anemia is highly prevalent in chronic kidney disease patients; however, its identification and management have been reported to be suboptimal. Therefore, the goals of our study were to evaluate the changes in a few hematological parameters between chronic kidney disease patients and controls, as well as to investigate the prevalence, severity and correlation of iron deficiency anemia in the 3-5 stages of chronic kidney disease patient. This case-control study was conducted on 120 sample of serum as a control and chronic kidney disease Patients, (male and female) with age ranged between (20-79) years. The severe anemia mostly was present in stage 5 was76.3%. The mean hemoglobin and iron level for the patient was 8.49±1.48 g/d L and 39.73±10.17 respectively. The anemia severity was also significantly different among stages of renal failure. Moreover, Regression analyses revealed that the mean hemoglobin and ferritin level were independent determinants of kidney failure stages.

**Keyword**: Iron deficiency anemia, chronic kidney disease, ferritin , Iron,hematological parameters .

# علاقة فقر الدم الناجم عن نقص الحديد مع 3-5 مراحل مرض الكلى المزمن دراسة الحالات والشواهد

**سالي ريسان جواد , ليلى سامي ابو هدل**

قسم التحليلات المرضية ,كلية العلوم , جامعة سومر ,ذي قار ,العراق

**الخلاصة**

فقر الدم منتشر بشكل كبير بين مرضى أمراض الكلى المزمنة. ومع ذلك، تم الإبلاغ عن تحديدها وإدارتها لتكون دون المستوى الأمثل. لذلك، كانت أهداف دراستنا هي تقييم التغيرات في بعض المعلمات الدموية بين مرضى أمراض الكلى المزمنة , والسليمين ، وكذلك للتحري في مدى انتشار وشدة وارتباط فقر الدم الناجم عن نقص الحديد في المراحل 3-5 من مرض الكلى المزمن. أجريت هذه الدراسة على 120 عينة من مصل الدم كمجموعة سيطرة ومرضى أمراض الكلى المزمنة (ذكور وإناث) تتراوح أعمارهم بين (20-79) سنة. فقر الدم الناجم عن نقص الحديد كان موجوداً في المرحلة الخامسة بنسبة 76.3%. كان متوسط مستوى الهيموجلوبين والحديد للمريض 8.49 ± 1.48 جم / د لتر و 39.73 ± 10.17 على التوالي. وكانت شدة فقر الدم أيضا مختلفة بشكل كبير بين مراحل الفشل الكلوي. علاوة على ذلك، أظهرت تحليلات الانحدار أن متوسط مستوى الهيموجلوبين والفيريتين كانا محددين مستقلين لمراحل الفشل الكلوي.

**الكلمات المفتاحية:** فقر الدم الناجم عن نقص الحديد,مرض الكلى المزمن ,الفيرتين,الحديد , محددات الدم.

## 1. Introduction:

Chronic kidney disease (CKD) is a problem for public health, and as kidney function begins to deteriorate, several complications appear. The repercussions of this illness are not limited to the renal system; they also have an impact on the whole homeostasis of the human body, where it is a multisystem disorder that has proved difficult to treat globally. Both developed and developing countries of the world have seen an increase in the prevalence of chronic Kidney disease in recent years [1, 2].

Anemia is one of the most severe and early effects of CKD, which can occur even in people with glomerular filtration rates (GFR) under 60 mL/min/1.73 m2 and gets worse as kidney function continues to decline [3] . Anemia is developed and has significant adverse outcomes when a disease developed and a kidney loses its ability to produce the erythropoietin essential to the production of hemoglobin [4]. The World Health Organization and the Kidney Disease Improving Global Outcomes claim that anemia in chronic kidney disease occurs when the Hb level is below 13 g/dL for men and below 12 g/dL for women, which impairs the ability of the blood to carry enough oxygen to meet the needs of the tissues [5]. Iron deficiency, the most common cause of anemia, accounts for more than half of all instances of anemia worldwide [6] . Other probable causes of anemia include infections, chronic illnesses like cancer, autoimmune diseases, chronic renal disease, and congestive heart failure, as well as deficiencies in non-iron hematopoietic nutrients such as folic acid, vitamin B12, and vitamin A [7, 8]. Excess mortality, hospitalizations for cardiovascular causes, and end-stage renal disease were found to be predicted by anemia. Anemia in CKD patients has been frequently associated with decreased quality of life as well as increased cardiovascular morbidity and death[9]. Numerous studies have found significant variations in the severity of anemia in CKD patients. According to statistics, the prevalence of anemia is 47.7% in the United States, 39.36% in India, 97.8% in Brazil, 51.5% in China, 79% in Cameroon, 43.18% in South Africa, and 64.5% in Ethiopia. A 3-fold greater risk of anemia was also present in African Americans compared to Whites [5].

Despite the fact that iron deficiency anemia is more common in women than in men and is brought on by decreased dietary iron intake and blood loss during menstruation, the relationship between sex variations in iron status and renal outcomes in patients with chronic kidney disease has not been thoroughly investigated [10]. According to earlier research, men develop renal function decrease more quickly than women, and the renal structure, varying hemodynamic responses, and influence of sex hormones may be the causes of sex dimorphism in CKD[10, 11].

The prevalence of anemia and the severity of CKD are strongly correlated, despite the fact that anemia may be identified in patients at any stage of the disease [12] , Iron deficiency anemia is now recognized as a distinct condition associated with CKD, whether or not the patient is reliant on dialysis [13]. Anemia in CKD is mostly caused by erythropoietin and iron deficiencies ,iron-deficiency anemia could be due to a true paucity of iron stores (absolute iron deficiency anemia) and relative (functional) iron deficiency , Risks associated with functional iron insufficiency may be reduced with improved iron status [14]. These patients need more specialized monitoring for their entire hematological and biochemical profile. If iron deficiency anemia is not diagnosed and treated promptly, these patients are more likely to experience problems like altered bone profile than people who do not have anemia. This could make CKD worse, making a patient more likely to need dialysis to survive [13], This could make CKD

worse, which would make the patient more likely to need dialysis to survive [5], Serum ferritin (SF), which is highly accurate and represents the state of iron storage [15-17]. Thus, in people receiving continuous hemodialysis, a change in serum ferritin levels may be a factor in mortality. In HD individuals, iron supplementation decreased mortality, but excessive iron therapy raised ferritin levels and increased mortality [18].

Anemia is a typical consequence in chronic kidney disease, which leads to the disease getting worse and increasing morbidity and mortality. Recently, there has been a substantial and notable increase in the number of renal disease patients in Iraq who are undergoing hemodialysis. Therefore, the goals of our study were to evaluate the changes in a few hematological parameters between chronic kidney disease patients and controls, as well as to investigate the prevalence, severity and correlation of iron deficiency anemia in the 3-5 stages of chronic kidney disease patient.

## 2. Material and Method

### *2.1 Patients and methods*

This case-control study was conducted on 120 sample of serum as a control and chronic kidney disease Patients, (male and female) with ages ranged between (20-79) years, which was conducted at the Al-Rifai General Hospital - from the beginning of November 2022 to April 2023.

Informed consent was obtained from all the participants, baseline demographic and clinical data was obtained from medical records and interviews with patients at enrolment. All the participants were requested to come with 10-12 hours of fasting for sample collection.

CKD stages were be divided into 5 stages established on glomerular filtration rate (GFR) levels based on the Kidney Disease: Improving Global Outcomes (KDIGO) 2012 Clinical Practice classification[19] : Stage 1,eGFR ≥90 ;Stage2,eGFR 60-89 ;stage 3, eGFR 30–59 ml/min; stage 4, eGFR 15–29 ml/min and stage 5, eGFR < 15 ml/min. In this study, stage 3 will be referred to as early stage of CKD and stages 4 and 5 as advanced stages. Hb <12.0 g/dL but >10.0 g/dL was defined as mild, Hb <10.0 g/dL but >8.0 g/ dL was defined as moderate and severe anemia was defined as Hb <8.0 g/dL. Serum Iron was analyses by enzymatic colorimetric method. Serum ferritin measured by were measured by using minividas . The criteria of hematology, hemoglobin (Hb) concentration, packed cell volume (PCV), white blood cell (WBC)and red blood cell (RBC) were measured by using automated hematological cell counting.

### *2.2 Statistical Analysis*

The results of the study were statistically analyzed using SPSS version23. The statistical differences between the groups were calculated using the chi-square test for nominal variables. The distribution normality of quantitative variables was calculated with the Shapiro-Wilk test. The t-test was used to show the difference between two groups at a probable level ($P < 0.05$) and the one-way ANOVA test to show the difference among three groups. The associations between each clinical parameter were calculated using Pearson correlation coefficients. The Odds Ratios (ORs) and their 95% CI were calculated by logistic regression analysis were used to determine any predictive effect of our variable on the outcome of disease.

## 3.Result and Discussion

### *3.1 General characteristics of the study population*

The general characteristics of the patients are shown in Table 1. Our study population includes 120 patients including 55 men (45.8%) and 65women (54.2%). the age distribution in renal failure showed a peak level in the age between (50-59) years represented by 40 patients and the least was in the age group between (70-79) years represented by 8 patients, Total 43 (35.8%) cases were in CKD stage 3, 37(30.8%) in stage 4 and 40 (33.3%) in stage 5. Our study patients with CKD,28 (23.3%)) had mild anemia, 54(45.0%)) had moderate anemia and 38 (31.7%) had severe anemia. Diabetes, hypertension, and cardiovascular system were present in 54 (45.0%), 102(85.0), and 78 (65.0%) of the study population, respectively.

**Table 1**-The baseline characteristic of the patient population.

| characteristics | Frequency | |
|---|---|---|
| | N | (%) |
| Gender | | |
| Male | 55 | (45.8%) |
| Female | 65 | (54.2%) |
| Total | 120 | (100.0%) |
| Age group | | |
| 20-29 | 10 | (8.3%) |
| 30-39 | 10 | (8.3%) |
| 40-49 | 35 | (29.2%) |
| 50-59 | 40 | (33.3%) |
| 60-69 | 17 | (14.2%) |
| 70-79 | 8 | (6.7%) |
| Total | 120 | (100.0%) |
| GFR mL/min/1.73 $m^2$ | | |
| GFR stage3 | 43 | (35.8%) |
| GFR stage4 | 37 | (30.8%) |
| GFRstage5 | 40 | ( 33.3%) |
| Total | 120 | (100.0%) |
| | | |
| Anemia | | |
| Mild<12g/dl | 28 | (23.3%) |
| moderate <10.0g/dl | 54 | (45.0%) |
| sever<8.0g/dl | 38 | (31.7%) |
| Total | 120 | (100.0) |
| Diabetes mellitus | | |
| No | 66 | (55.0%) |
| Yes | 54 | ( 45.0%) |
| Total | 120 | ( 100%) |
| Cardio vascular disease | | |
| No | 42 | (35.0%) |
| Yes | 78 | (65.0%) |
| Total | 120 | ( 100.0) |
| Hypertension | | |
| No | 18 | (15.0%) |
| Yes | 102 | (85.0%) |
| Total | 120 | (100.0) |

*3.2 The prevalence of anemia with stage of chronic kidney disease*

Our study demonstrates the negative association between the prevalence of anemia and eGFR, indicating that the percentage of the patients with anemia increases while kidney function decreases. The percentage of the patients with Hb smaller than 12 g/dL was significantly higher in stage 3 than stage 4 and 5 CKD patients (85.7% vs 10.7% and 3.6%, respectively, p=0.001). Conversely, the percentage of the patients with Hb<10 g/dL was significantly higher in stage 4 than stage 3 and 5 CKD (46.3%vs35.2 %and18.5 %, respectively, p<0.001). while the percentage of the patients with Hb <8 g/dL severe anemia was significantly higher in stage 5 than stage 3 and 4 CKD (76.3%vs 0.0% and 23.7%, respectively, p<0.001). There were a positive association between the age and a stage of chronic kidney disease (p=0,006). While, there was no association between the severity of disease and gender as in (Table2; figure1). Moreover, we observed in our data that anemia in CKD is age-independent as illustrated in figure 2.

**Table 2-** The prevalence of anemia and age-specific subgroup according to stages of chronic Kidney disease.

| **Parameters** | **CKD stage (GFR mL/min/1.73 m2)** | | | | | | **P value** |
|---|---|---|---|---|---|---|---|
| | **Stage 3** | | **Stage4** | | **Stage5** | | |
| | **N** | **%** | **N** | **%** | **N** | **%** | |
| **Hb < 12g/dl (mild anemia)** | 24 | 85.7% | 3 | 10.7% | 1 | 3.6% | 0.001 |
| **Hb < 10g/dl(moderate anemia)** | 19 | 35.2% | 25 | 46.3% | 10 | 18.5% | |
| **Hb < 8 g/dl(Severe anemia)** | 0 | 0.0% | 9 | 23.7% | 29 | 76.3% | |
| **Age group** | | | | | | | |
| 20-29 | 2 | 20.0% | 5 | 50.0% | 3 | 30.0% | 0.006 |
| 30-39 | 4 | 40.0% | 4 | 40.0% | 2 | 20.0% | |
| 40-49 | 14 | 40.0% | 11 | 31.4% | 10 | 28.6% | |
| 50-59 | 13 | 32.5% | 15 | 37.5% | 12 | 30.0% | |
| 60-69 | 4 | 23.5% | 2 | 11.8% | 11 | 64.7% | |
| 70-79 | 0 | 0.0% | 0 | 0.0% | 8 | 100.0% | |

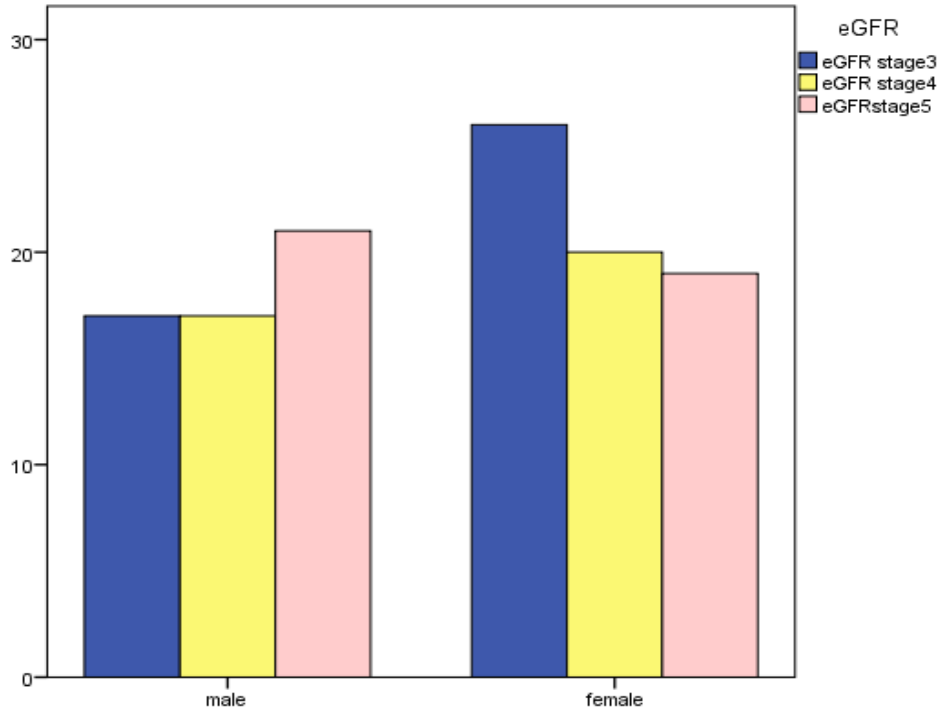


**Figure-1** The prevalence of chronic kidney disease among gender

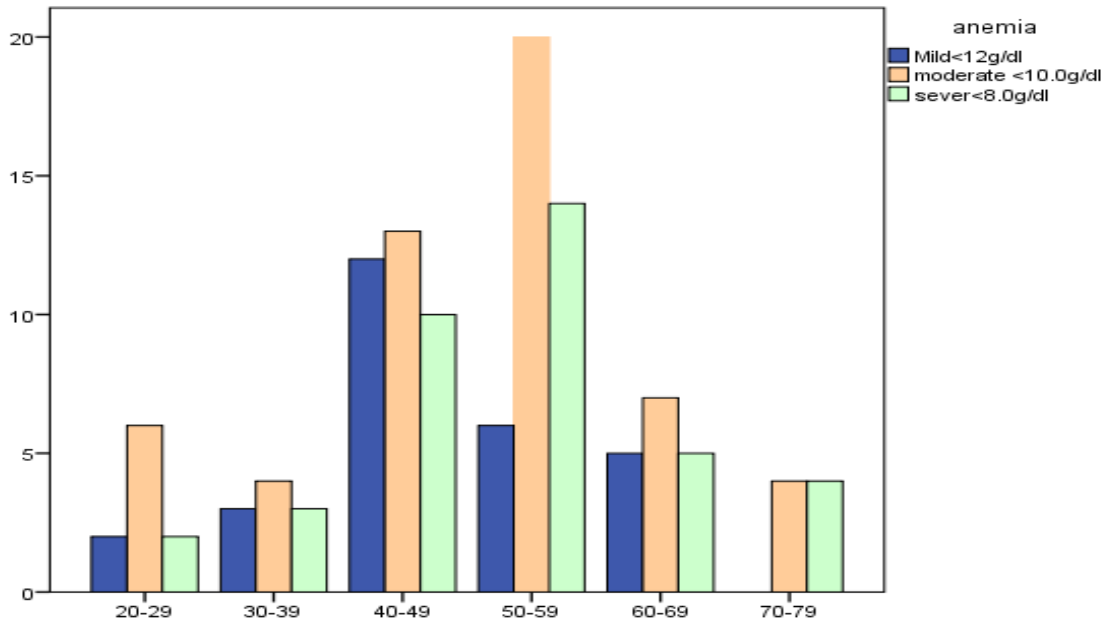


**Figure -2** The distribution of age group according anemia among chronic kidney disease patient.

*3.3 Comparison of research variables between the patient group and the healthy group as well as between the male and female patient groups*

The statistical analysis showed highly significant increase (P=0.0001) in mean of RBCs, Hb, PCV, WBC, ferritin and iron in patients with CKD paralleled to the healthy group. Results appeared all patients with Hb levels had anemia (8.49±1.48) compared to (12.90±1.03) in the healthy control group as in Table3. Furthermore, there were no significant differences in Hb and RBC between male and female where Hb levels in males (8.38 ±1.55) were slightly higher than female. there was significant difference between males and females in iron and WBC (P=0.003), (p=0.001) respectively as shown in table 4. Our result revealed that study parameters Hb, PCV, RBc and iron levels in CKD3 were significantly higher (P < 0.05) than in CKD4,5. Meanwhile, The mean of ferritin level increase with stage of CKD (151.76±94.51) at stage 3 and (494.50±259.28) at stage 5. In fact, the wbc levels were no significantly different (0.357) between stage of CKD as in table 5.

**Table 3-** Comparing mean±SD for patients with chronic kidney disease and healthy people.

| **parameters** | **Patient (Mean ± S.D)** | **Control (Mean ± S.D)** | **p-value** |
|---|---|---|---|
| **Hb (g/dl)** | 8.49±1.48 | 12.90±1.03 | 0.0001 |
| **PCV (%)** | 27.61±2.83 | 45.38 ±2.45 | 0.0001 |
| **RBC($10^{12}$/l)** | 2.88±0.57 | 5.13±0.70 | 0.0001 |
| **WBC ($10^9$/l)** | 8.70±1.87 | 6.87±1.42 | 0.0001 |
| **Ferritin (ng/dl )** | 328.09±224.75 | 100.22±45.83 | 0.0001 |
| **Iron (mg/dl)** | 39.73±10.17 | 79.38±16.00 | 0.0001 |

Hb= Hemoglobin, PCV= packed cell volume, wbc=white blood cell , and RBC= Red blood cell.

**Table 4-** The mean ± S.D concentrations of hematological parameters between male and female for study patients.

| Variable | Male (Mean ± S.D) | Female(Mean ± S.D) | P- value |
|---|---|---|---|
| Hb (g/dl) | 8.38 ±1.55 | 8.58±1.43 | 0.460 |
| WBC($10^9$/l) | 8.74±2.01 | 7.78±2.28 | 0.001 |
| RBC($10^{12}$/l) | 2.84±0.54 | 2.90±0. 60 | 0.57 |
| PCV(%) | 27.21±3.14 | 27.95±2.52 | 0.15 |
| Iron (mg/dl) | 42.69±10.06 | 37.229.65 | 0.003 |
| Ferritin( ng/dl ) | 376.76±237.15 | 286.90±206.66 | 0.02 |

Hb= Hemoglobin, PCV= packed cell volume, wbc=white blood cell , and RBC= Red blood cell.

**Table 5-** Stages of anemia measuring factors in individuals with chronic renal dysfunction

| parameters | Stage 3 (Mean ± S.D) | Stage 4 (Mean ± S.D) | Stage5 (Mean ± S.D) | p-value |
|---|---|---|---|---|
| **Hb(g/dl)** | 9.86±0.83 | 8.43±1.04 | 7.07±0.94 | 0.0001 |
| **pcv(%)** | 29.60±1.73 | 28.00±1.50 | 25.12±2.89 | 0.0001 |
| **wbc($10^9$/l)** | 8.59±1.99 | 8.14±2.42 | 7.90±2.21 | 0.357 |
| **RBc($10^{12}$/l)** | 3.27±0.56 | 2.81±0.46 | 2.51±0.39 | 0.0001 |
| **ferritin( ng/dl )** | 151.76±94.51 | 353.10±123.19 | 494.50±259.28 | 0.0001 |
| **Iron(mg/dl)** | 45.33±9.85 | 38.89±9.92 | 34.49±7.55 | 0.0001 |

Hb= Hemoglobin, PCV= packed cell volume, wbc=white blood cell, RBC= Red blood cell and eGFR= estimated glomerular filtration rate

### *3.4 Correlation Studies*

By investigating the correlation between Hb and tested study parameters, we found that no correlations were detected between Hb and WBC in our study (r=0.119, p = 0.194). However, there was a significant positive association between Hb and pcv (r =0.818, p = 0.0001). Meanwhile Hb levels exert a significant positive correlation with iron, ferritin and eGFR (p= 0.0001) as in table 6. Serum ferritin level was significantly correlated with eGFR (r = 0. 638, p = 0.0001), While there were no correlations between ferritin level and wbc (p=0.237).

**Table 6-** Correlation of study parameters with Hb and ferritin in patients with chronic Kidney disease.

| variable | Hb | | Ferritin | |
|---|---|---|---|---|
| | R | p-value | R | p-value |
| **WBC($10^9$/l)** | 0.119 | 0.194 | 0.109 | 0.237 |
| **pcv(%)** | 0.818 ** | 0.0001 | 0.482** | 0.0001 |
| **iron (mg/dl)** | 0.641** | 0.0001 | 0.174 | 0.05 |
| **eGFR( mL/min/1.73 $m^2$ )** | 0.781 | 0.0001 | 0.638 | 0.0001 |
| **ferritin( ng/dl )** | 0.521** | 0.0001 | | |

Hb= Hemoglobin, PCV= packed cell volume, wbc=white blood cell and eGFR= estimated glomerular filtration rate, * * =p ≤ 0.01.

### *3.5 Regression analysis*

We used logistic regression analysis to examine the independent variables associated with severe renal disease. the odds of anemia (OR: 0.054, 95% CI: 0.018-0.158) decreased with stage 5 than stage 4. ferritin was found to be significantly related to stage of kidney disease with (p=0.0001; OR:1.022 ;95% CI: 1.014-1.030) in the stage 5, and (OR:1.017 ;95% CI: 1.010-1.025) compared to stage 3. Iron level significantly decease with the stage 5 compare with stage 4 (p = 0.0001; OR: 0.842; 95% CI: 0.778-0.912) as in table 7.

**Table 7-** Factors associated with stage of chronic kidney disease

| Variable | eGFR stage 4 | | eGFR stage 5 | |
|---|---|---|---|---|
| | **OR (95%CI)** | **P value** | **OR (95%CI)** | **P value** |
| **Gender** | | | | |
| **Male** | 1.300 (0.534-3.165) | 0.563 | 1.690(0.707-4.039) | 0.238 |
| **Female(reference)** | | | | |
| **HB** | 0 .190 (0.078-0.462) | 0.000 | 0.054 (0.018-0.158) | 0.000 |
| **Ferritin** | 1.017(1.010-1.025) | 0.000 | 1.022(1.014-1.030) | 0.000 |
| **iron** | 0.908(0.851-0.969) | 0. 004 | 0.842 (0.778-0.912) | 0.000 |
| **WBC** | 0.919(0.727-1.162) | 0.480 | 0.929(0.709-1.218) | 0.593 |
| **RBC** | 0.503 (0.170-1.488) | 0.214 | 0.490(0.097-2.473) | 0.388 |
| **pcv** | 0.596(0.432-0.823) | 0.002 | 0.353(0.242-0.514) | 0.000 |

The reference category is: eGFR stage3, CI: confidence interval, eGFR: estimated glomerular filtration rate, OR: odds ratio, Hb= Hemoglobin, PCV= packed cell volume, wbc=white blood cell, eGFR= estimated glomerular filtration, RBC=Red blood cell.

The results of our study indicate that women are more likely than men to acquire CKD, and that males also have a higher risk of death and a faster rate of progression. These findings are broken down by sex. Patients who were older and female had a greater frequency of chronic kidney disease (CKD), which is in line with findings from prior research in the Korean and other population[20-22]. The male group was determined to be higher than the female group in a different study, but statistical analysis did not reveal a significant difference between the two groups in this one [23] . our investigation revealed that the patients who have renal disease were in all age groups, that confirmed from reports from other author[24]. Moreover, we found that 85.0% of patients have hypertension. The relationship between hypertension, cardiovascular risk, and the development of CKD is well known to progress with CKD and increase the risk rate for cardiovascular occurrence. The main risk factor that may be changed for heart disease, renal disease, and stroke is hypertension [25]. In addition to being a prevalent cause of hypertension, chronic kidney disease is also a risk factor for uncontrolled hypertension [26].

Several studies have shown that iron deficiency anemia is one of the most important adverse effects of chronic renal illness[27, 28]. Iron deficiency anemia may be present at 3-5 stages of chronic kidney disease, and there is a strong correlation between the incidence of iron deficiency anemia and the severity of chronic kidney disease stages where the prevalence of severe anemia (Hb >8 g/dl) increases in stage 5 (76.3%), while the prevalence of mild anemia (Hb >12 g/dl) increases in stage 3 [4, 29, 30] . Lack of the iron element that is a part of the hemoglobin molecule's chemical makeup is one of the major causes of low hemoglobin concentration. Its deficit may be brought on by the inadequate nutrition that people with chronic renal failure face as well as the obstruction of iron absorption from the intestine induced by the high level of cytokines. Other factors that contribute to anemia in people with chronic renal

failure include the buildup of nitrogenous wastes in the blood that prevent the generation of red blood cells in the bone marrow[28].

Our data showed that when eGFR values fell, iron deficiency anemia was increasingly prevalent across all age groups. This result appears to validate our research and is consistent with results from a different sample of people in the National Health and Nutrition Examination Survey population.[31, 32]. In accordance with a different study [25] our study found that chronic renal disease progression was most prevalent in older adults (55-79). The disease becomes more complex in these age ranges, which is agreement also with local research [20]. According to the explanation of a previous study, the majority of Iraqi patients suffer from diabetes mellitus or hypertension, the two illnesses that most commonly cause chronic renal failure, especially in older patients. They either follow their medication regimen poorly or receive restricted therapy[23] .

We investigation on the impact of chronic kidney disease on hematological variable is presented in Table 3, where we find that patients with CKD have significantly decrease red blood cell counts, hemoglobin levels, and packed cell volume when compared to healthy group, which is consistent with earlier studies from Iraq [29, 33, 34]. This is caused by a deficiency in the hormone erythropoietin, which is essential for the promotion and production of red blood cells in the bone marrow. Erythropoietin is produced by the renal tubule cells that encircle them; damage to these cells would cause a reduction in the hormone's release[25] .

The results of our investigation align with those of earlier studies [28]. In that they show a significant increase ($P < 0.05$) in the number of white blood cells in the blood of chronic renal failure patients when compared to the healthy group. The inflammatory conditions that come with uremia and hemodialysis therapy may have caused an increase in white blood cell production [34]. Additionally, the study found no significant differences ($p>0.05$) between male and female patients with chronic renal insufficiency in terms of their Hb, RBC, and PCV concentrations [29]. Male and female patients with chronic renal insufficiency had significantly different white blood cell counts in our study ($p=0.001$). The mean for men was$8.74\pm2.01$ where as the mean for women was$7.78\pm2.28$.

We revealed that hematological parameters are decreased as CKD progresses, and patients with advanced CKD (stage 5) had a significant association with anemia. In addition to developing chronic renal failure, patients with anemia are more likely to develop infections and hemorrhage , as previously reported in studies from Australia, Korea, New York, and Florida [5, 35, 36]. According to a study that looked at the relationship between Kidney Disease Quality of Life questionnaire domains and Hb levels in 1,200 patients with stages 3, 4, and 5 CKD, higher Hb levels were linked to improved QoL domains of the KDQofL questionnaire ($p=0.0001$). Our study found a positive correlation between Hb and eGFR, which is in agreement with a study that found a similar correlation between Hb and eGFR[1, 37] .

According to our findings, the stage of CKD and iron deficiency are negatively correlated.; Table 3 shows that serum patients' iron concentration was substantially lower ($p= 0.001$) than that of the control group. These outcomes matched those that had been previously published. A study assessing the storage of iron in bone marrow found that more than half of individuals with CKD 3-5 ND and hemoglobin levels of 11 g/dL had iron deficiency [38, 39]. Anemia from iron deficiency can occur in people with chronic kidney disease due to dietary deficiencies, reduced

gastrointestinal bleeding, and decreased intestinal absorption of iron. Serum iron levels have been related to worse renal outcomes [40] .

When compared to controls, our study shows that kidney disease patients had considerably higher blood levels of ferritin, and this finding is consistent with another study. [41], ferritin levels varied inversely with hemoglobin levels, as shown in table 5 where high level of ferritin found in stage 5 with mean 494.50 more than stage 4 and 3 (353.10 and 151.76 )respectively with decrease the level of Hb this finding was comparable to other researchers [17]. This may be explained by the fact that serum ferritin is a strong acute phase reactant and frequently accompanied with an increase in CRP levels and inflammation [42]. Inflammatory cytokines may prevent iron from reaching the bone marrow for use or may cause a rise in serum ferritin levels in the blood [12, 43]. Iron-deficient individuals may exhibit elevated ferritin levels as a result of illness, inflammation, malnutrition, or cancer[44]. There is a positive correlation between ferritin and iron in our study (p=0.0001) Serum ferritin is thought to be a marker of iron storage, and absolute iron deficiency is a measure of circulating accessible iron and represents functional iron insufficiency. [45]. According to the results of the current study, kidney disorders advance more quickly when ferritin levels rise and iron levels fall. Measured ferritin levels are directly correlated with the overall quantity of iron stored in the body, including anemia and chronic illness instances. An overabundance of iron is present if ferritin levels are high. Low levels of iron indices were discovered in most CKD patients in a research based on NHANES data from 1988 to 2004 [41] . Improved outcomes for CKD patients depend on the management of IDA with iron supplementation. However, extensive iron therapy results in iatrogenic iron overload, which brings on inflammation and raises the risk of death [46].

Furthermore, ferritin, serum iron levels, and hemoglobin were found to be independent predictors of the development of renal failure in a regression coefficient study. Research have demonstrated that a reduction in the progression of renal disease as well as enhanced energy, work capacity, health-related quality of life, cognitive function, and cardiac function are linked to early identification and timely treatment of anemia in patients with chronic kidney disease (CKD) by nearly normalizing hemoglobin and iron levels. In cases when anemia is predictive of increased mortality in the late stages of chronic kidney disease (CKD), certain research has demonstrated this death in the advanced stages of CKD. Additionally, studies demonstrate a positive correlation between quality of life measures and increasing hemoglobin levels. [47].

## 4. Conclusions

According to the results of our study, iron deficiency anemia is more common in the 3-5 stages of chronic kidney disease (CKD) patients compared to controls, and there is a clear association between the two diseases. Hematological variables were also reduced in CKD patients. The progression of renal Failure in the patient is closely connected and predicted by the iron, Hb, and ferritin levels. Iron deficiency anemia is a typical consequence in chronic kidney disease, which leads to the disease getting worse and increasing morbidity and mortality.

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